The Holy Grail of Agile Acquisition

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Dr. Hantos is a Senior Engineering Specialist in the Software Acquisition and Process Department of The Aerospace Corporation. In this capacity he supports the US Air Force and various customers of Aerospace's National Systems Group in acquiring military satellite systems. He has over 35 years of combined experience as professor, researcher, software engineer and manager, with accomplishments in software engineering, manufacturing automation, office automation and signal processing.

As a senior software engineer at Xerox he was member of the original development team that was chartered to bring into the product development domain the world-known inventions from the Xerox Palo Alto Research Center (PARC), primarily the use of the desktop, icons, mouse-control and network paradigms. Successfully directed engineering and quality process development on all levels of the enterprise. As principal scientist of the Xerox Corporate Software Engineering Center developed and implemented two corporate-wide processes for software-intensive product development and for the assessment of software technology readiness. In the same capacity he also implemented a corporate-wide software risk assessment program. He holds M.S. and Ph.D. degrees in Electrical Engineering from the Technical University of Budapest, Hungary.

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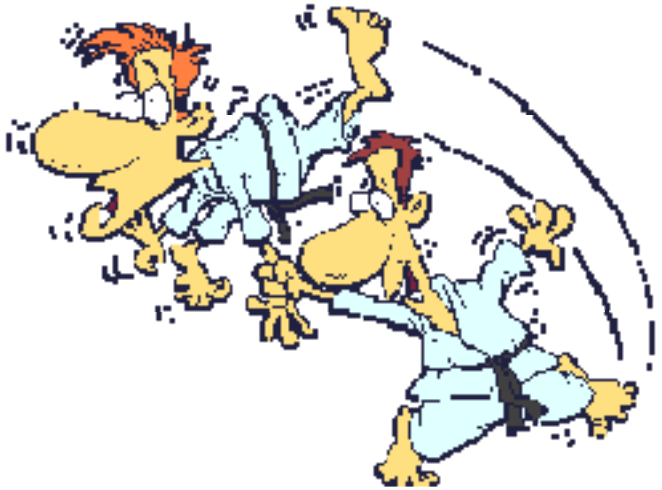
Background

- Emergence of new buzzwords in software development
  - *Competitive pressures of the 1990s forced software companies to re-examine their development processes and adopt radical approaches. As a result, the industry has been flooded with buzzwords associated with "new" development approaches, e.g., "internet time", "extreme", and "agile"*
- A flood of more management buzzwords over the past 30 years…
  - *There has been a "bandwagon effect" of popular management movements such as Total Quality Management, management by objectives, reinventing government, reengineering, the balanced scorecard, Lean, and Six Sigma*
    - However, companies that have been earlier identified as excellent on the basis of these practices later turned out to be mediocre or outright failure [Paparone 2009]
  - *Attempts have been made to bring agility into the Air Force acquisition process as well [Evans 2003]*
    - Unfortunately, the Agile Acquisition initiative did not gain any traction
- Consequently, the recent recommendation to Pentagon Brass: "Stay Away from Management Bestsellers…" [Erwin 2009]

Motivation

- Despite of Erwin's recommendation…
  - *Agility seems to be a simple concept and it is commonly perceived as a virtue*
  - *Agile methods are making inroads into software development*
- Consequently, the idea of making acquisition agile deserves a closer view

What is Agility?



- The narrow dictionary definition:
  - *Ready ability to move with quick easy grace*
  - *Agile is being quick and resourceful*
    - Agility is perceived a virtue
    - In business, agility is considered an important organizational capability
- Unfortunately, in most contexts it is ill-defined or inconsistent
  - *Agility does not simply equate with speed, as the following examples show*
    - Agility conflicts with speed
      - *The Titanic's ability to turn sharply is far more likely to avert disaster than increasing its top speed charging straight ahead*
    - Agility requires speed but also requires balance
      - *Martial arts*
  - *"Lean" does not always equate with "agile"*
    - Applying "Lean" might increase the rigidity of a process
      - *Rigidity results from constraining the process in order to optimize the case "right now"*

Agility in Different Contexts

- Agility in Software Development
  - *The prevailing characteristic of an agile software development organization is that it institutionally embraces the agile values of the Agile Manifesto [Agile 2001]:*
    - **Individuals and interactions** over processes and tools
    - **Working software** over comprehensive documentation
    - **Customer collaboration** over contract negotiation
    - **Responding to change** over following a plan
- Agility in Business
  - *Authors try to resolve the earlier discussed confusion by considering agility as a two-dimensional factor [Masini 2005] :*
    - **Range Agility – speed**
    - **Time Agility – reaction**
  - *They concluded that when it comes to agility, more is not always better; the benefits are bounded and are contingent on ease and market dynamics*

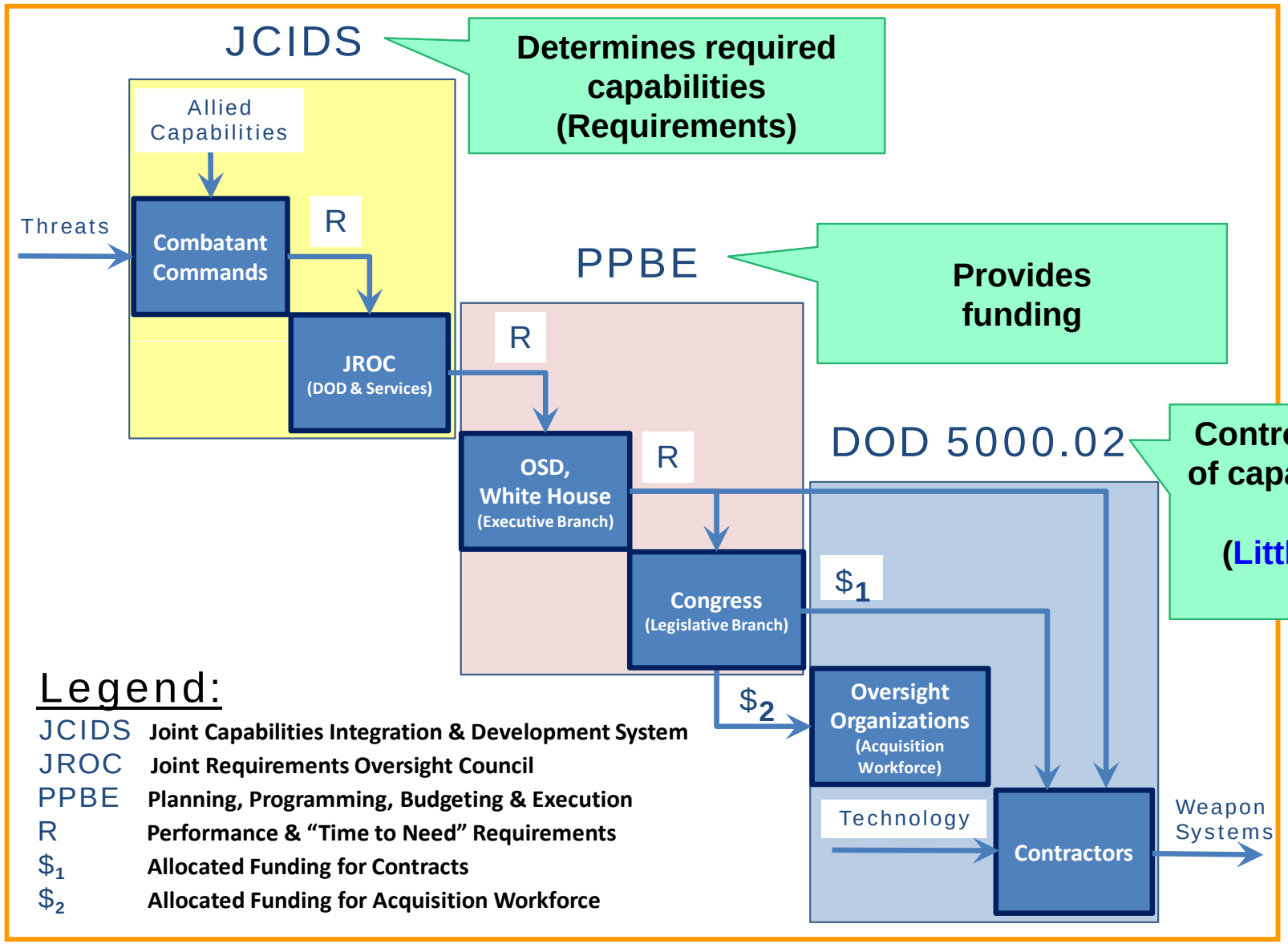
Agility in Defense

- Agility in Defense
  - *There is a confusion about the need for systems enabling **war-fighter agility** vs. the need for **agile acquisition of weapon systems***
    - There is no argument about the value of war-fighter agility. However,
      - *War-fighter agility can be primarily supported via weapons design and flexible architecture*
      - *Faster access to new weapons is not always the right solution*
      - *Fast procurement of established weapons is important, but out of scope for this discussion*
- Agility in Defense Acquisition
  - *This is the topic of this presentation*

Approach

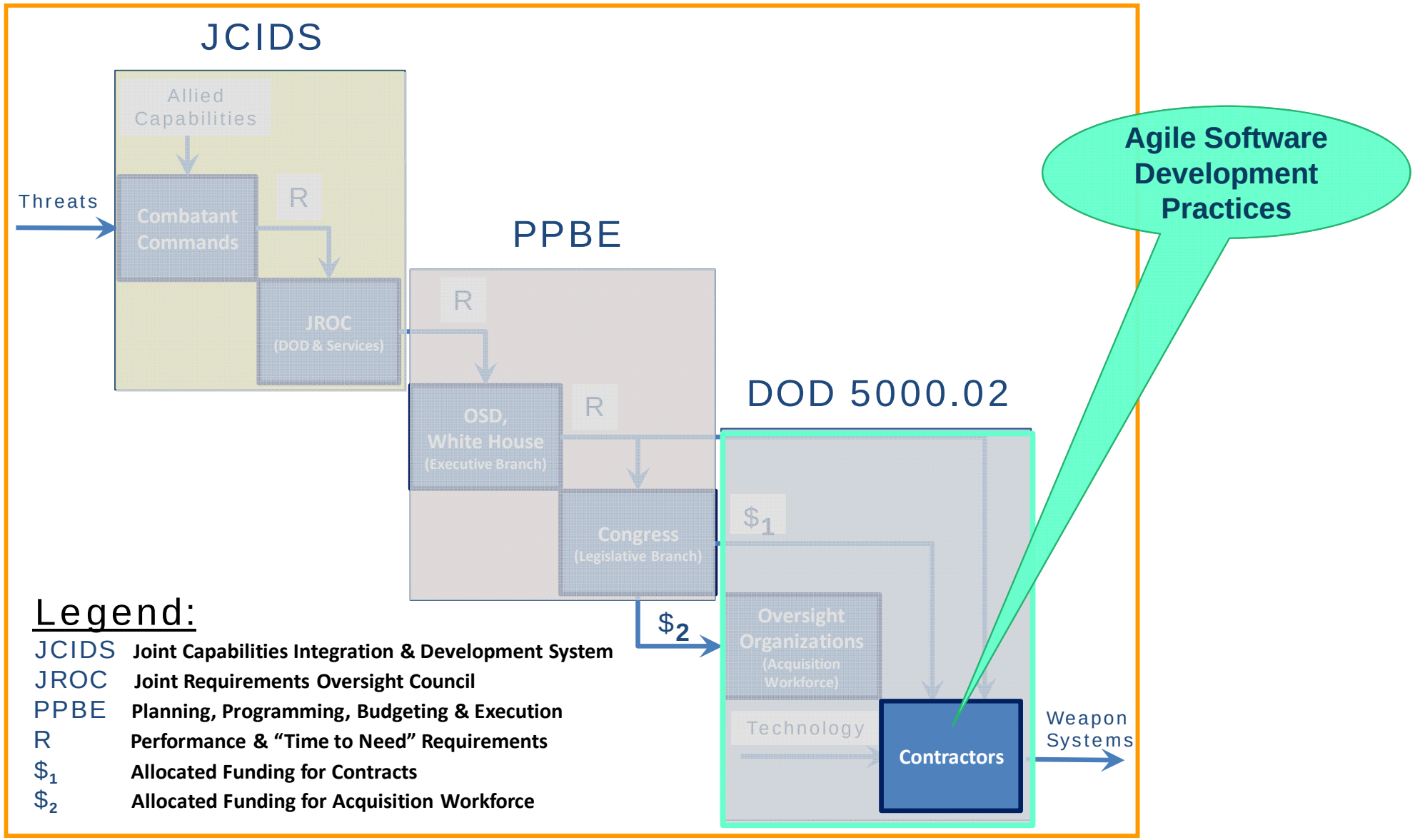
- The defense acquisition system is frequently reformed
  - *The Defense Acquisition Performance Assessment (DAPA) of 2006 mentions 9 major, prior acquisition reforms, DAPA itself is the 10th, and the most recent, Weapon Systems Acquisition Reform Act (WSARA) of 2009 is the 11th…*
  - *It is worthwhile to pause and see if the recommendations call for agility*
- These reforms are always based on identified problems or outright failures of the acquisition system
  - *Conversely, it is also interesting to explore if agile ideas, e.g., Agile Software Development or the Air Force's Agile Acquisition Initiative, are appropriate to mitigate the identified problems or failures*

Context: The Acquisition System (Big "A" Acquisition Process)



Perceived to be a simple construct of three, well integrated inter-dependent processes

Agile Software Development for New Weapon Systems



Agile Development affects only the smaller context of the DOD 5000.02 process

AEROSPACE

Examining Agile Software Development Values

- Individuals and interactions over processes and tools
  - *This value and the associated practices work well in limited settings but do not scale up*
    - E.g., the following numbers represent space system development
      - *Space Vehicle Software is embedded, very large*
        - Typical size 512 Thousand Delivered Source Instructions (KDSI), including bus software and payload(s)
      - *Ground Systems are even larger*
        - Space Shuttle size 2,000 KDSI
        - Satellite control systems ~ 4,700 KDSI

The role of tools and processes is very critical in the development of such large, mission-critical systems

Examining Agile Software Development Values (cont.)

- Individuals and interactions over processes and tools (cont.)
  - *The following data shows the volatility of the work force**
    - Government Sector
      - *Average Annual Separation Rate **17.4%** of total Government Sector employment*
      - *Average Annual Hires Rate **18.6%***
    - Information Industry
      - *Average Annual Separation Rate **38.3%** of total Information Industry employment*
      - *Average Annual Hires Rate **34%***

In such a volatile environment development cannot simply depend on individuals and interactions

- Working software over comprehensive documentation

Based on all the previous arguments, this is not a realistic principle either

** Source: Bureau of Labor Statistical Database for the period of 2001 - 2008*

Examining Agile Software Development Values (cont.)

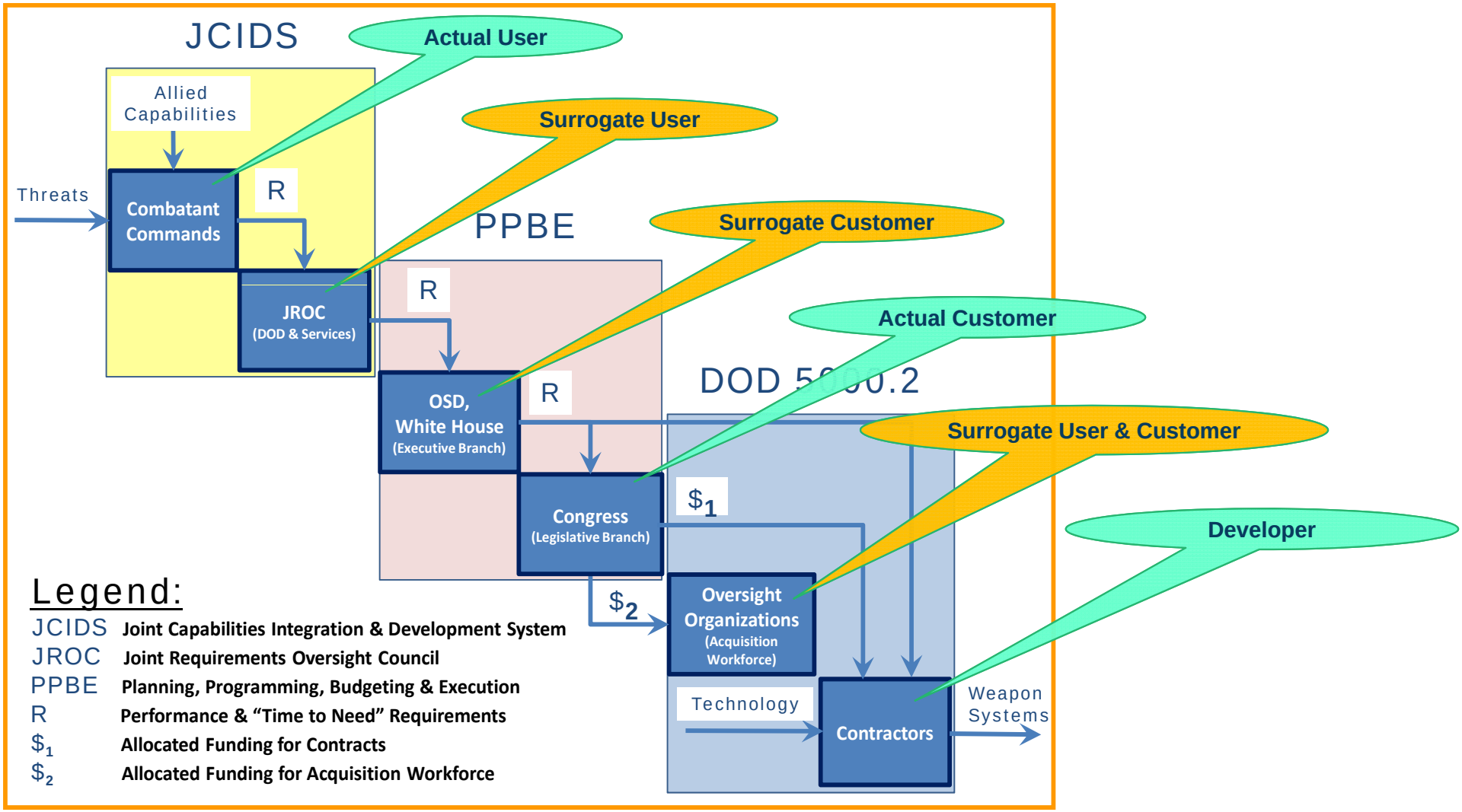
- Customer collaboration over contract negotiation
  - *The Developer is far removed from the Actual User and Actual Customer (see next slide)*
    - Also, there is a substantial tension between the numerous stakeholders

At the given scale, maintaining constant collaboration even with the surrogate customers is very difficult

- Responding to change over following a plan
  - *The mentioned, typical space vehicle software development of 512 KDSI would require roughly a **6,420 Man-Month** effort, spreading over **41 months**, involving **~157 Full-time Equivalent Software Personnel***

At the given scale, maintaining internal collaboration without coordinated plans is not feasible either

Key Stakeholders in the Big “A” Acquisition Process



- There is a tension between the numerous stakeholders due to different motivation/behavior
- The process elements themselves are complex and ambiguous
- Process integration is not efficient and the overall system is unstable

Final Thoughts on Agile Software Development

- Agile ideas using the rugby metaphor for product development emerged as early as 1986 from H. Takeuchi and I. Nonaka [Takeuchi 1986]:
  - *Top management offers only a general strategic direction and challenging goals (Does not provide a specific work plan)*
  - *Hand-picked but self-organizing multi-disciplinary teams*
  - *Members work together from start to finish*
  - *Process is characterized by constant interaction ("cross-fertilization")*
  - *Multi-level (individual and group) and multi-functional learning*
- However, even Takeuchi and Nonaka noted that this holistic approach may not work in all situations:
  - *It **requires extraordinary effort** throughout the span of the development process (excessive monthly overtime – not sustainable in the long run)*
  - *It **may not apply to breakthrough projects** that require innovation*
    - Note that immature technology belongs to this category
  - *It **may not apply to "mammoth" projects** where the sheer project scale limits extensive face-to-face discussions*
    - Takeuchi & Nonaka specifically mention aerospace
  - *The **cultural dimensions were not analyzed** for these approaches*
    - All of the studied companies were Japanese

What is Really Important? Mission Success!

- There is no declared, explicit value statement about Mission Success for Agile Development
  - ***However, Mission Success in defense acquisition is essential!***
- The definition of Mission Success [Guarro 2007]
  - *The achievement by an acquired system (or system of systems) to singularly or in combination meet not only specified performance requirements but also expectations of users and operators in terms of safety, operability, suitability, and supportability*
- The definition of Mission Assurance [Guarro 2007]
  - *The disciplined application of general systems engineering, quality, and management principles towards the goal of achieving Mission Success, and towards this goal, this disciplined application provides confidence in its achievement*
- How can you ensure that high mission assurance processes are used to develop your software?
  - *Use a robust software development standard [Eslinger 06]*
    - Eslinger argues that even the use of so-called mature processes, such as defined by the CMMI® is inadequate, and **the government must make a robust software standard contractually compliant**

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Major Areas in a Typical Software Development Standard*

System and Software Architecture
Human Systems Integration
Interoperability and Standardization
Metrics
Reliability, Safety, Information Assurance
Project Planning and Oversight
SW Development Environment
System Requirements Analysis
SW Requirements Analysis
SW Design
SW Implementation and Unit Testing
Unit Integration and Testing
SW Qualification Testing

Preparing for Transition to Operations and Maintenance
Software Configuration Management
SW Peer Reviews and Product Evaluations
SW Quality Assurance
Corrective Action
Joint Technical and Management Reviews
Risk Management
SW Management Indicators (Metrics)
Security and Privacy
Subcontractor Management
Interface with Software IV&V Agents

** Source: [Adams 05]*

In Summary, What Can We Learn From My Dentist?

Sign in my dentist's office:
"Brush only those teeth you wish to keep…"

The Air Force's Agile Acquisition Initiative

- Championed by Dr. Marvin R. Sambur, then Assistant Secretary of the Air Force for Acquisition*
  - *Theme #1: Warfighter developed requirements and "tossed over the wall"; acquirers tried to translate warfighter needs to contract documents*
    - Recommendation: Working together as a team
      - *This is a true agile concern, impacting the Big "A" Acquisition Process*
      - *However, there are problems with "jointness" in JROC*
      - *Managing service advocacy conflicts with the idea of managing the DOD as an enterprise*
      - *Warfighter requirements are always tactical; the strategic perspective is missing*

The underlying problems run deep, and the recommendation did not offer tangible solutions

** Source: [Evans 2003]*

The Air Force's Agile Acquisition Initiative (Cont.)

- *Theme #2: Focused Technology Transfer*
  - Recommendation: Foster closer working relationship between labs and programs and realign high-priority, limited resources
    - *This is a true agile concern. However, the majority of breakthrough technologies, particularly technologies used in space, are developed by contractors and commercial industry, and not the Air Force Research Lab (AFRL)**

Labs can be directed to work on defense technology development, but industry needs to be incentivized

- *Theme #3: "Seams" between developmental testing and operational testing*
  - Recommendation: Seamless verification
    - *Bringing-in testers early to get advice on testability of requirements is not necessarily an agile concern, but there is no controversy involved*
    - *However, it is also a euphemism for incremental sell-off of requirements*

Impartial and independent Operational Testing and Evaluation (OT&E) must not be weakened

** This is particularly true for software*

Defense Acquisition Performance Assessment of 2006

- Selected DAPA recommendations with possible agile consequences*
  - *Targeting the PPBE process (Budgeting)*
    - Transform and stabilize the Planning, Programming, Budgeting, and Execution (PPBE) process
      - *Establish a distinct, Stable Program Funding Account*
      - *Program all accounts to an 80/20 confidence level*
  - *Targeting the JCIDS process (Requirements)*
    - Replace the JCIDS (Joint Capabilities Integration Development System) with a new, two-year recurring planning process based on the 15-year extended plans submitted by Combatant Commands
    - Create a new, “Operationally Acceptable” test category
  - *Targeting the little “a” Acquisition Process*
    - Establish Time Certain Development as a preferred acquisition strategy
      - *Make time a Key Performance Parameter (KPP)*
    - Establish a realistic capability delivery rate even before MS A
    - Complete the Test & Evaluation Management Plan (TEMP) and the Initial Operational Testing & Evaluation Plan (IOT&EP) prior Milestone B

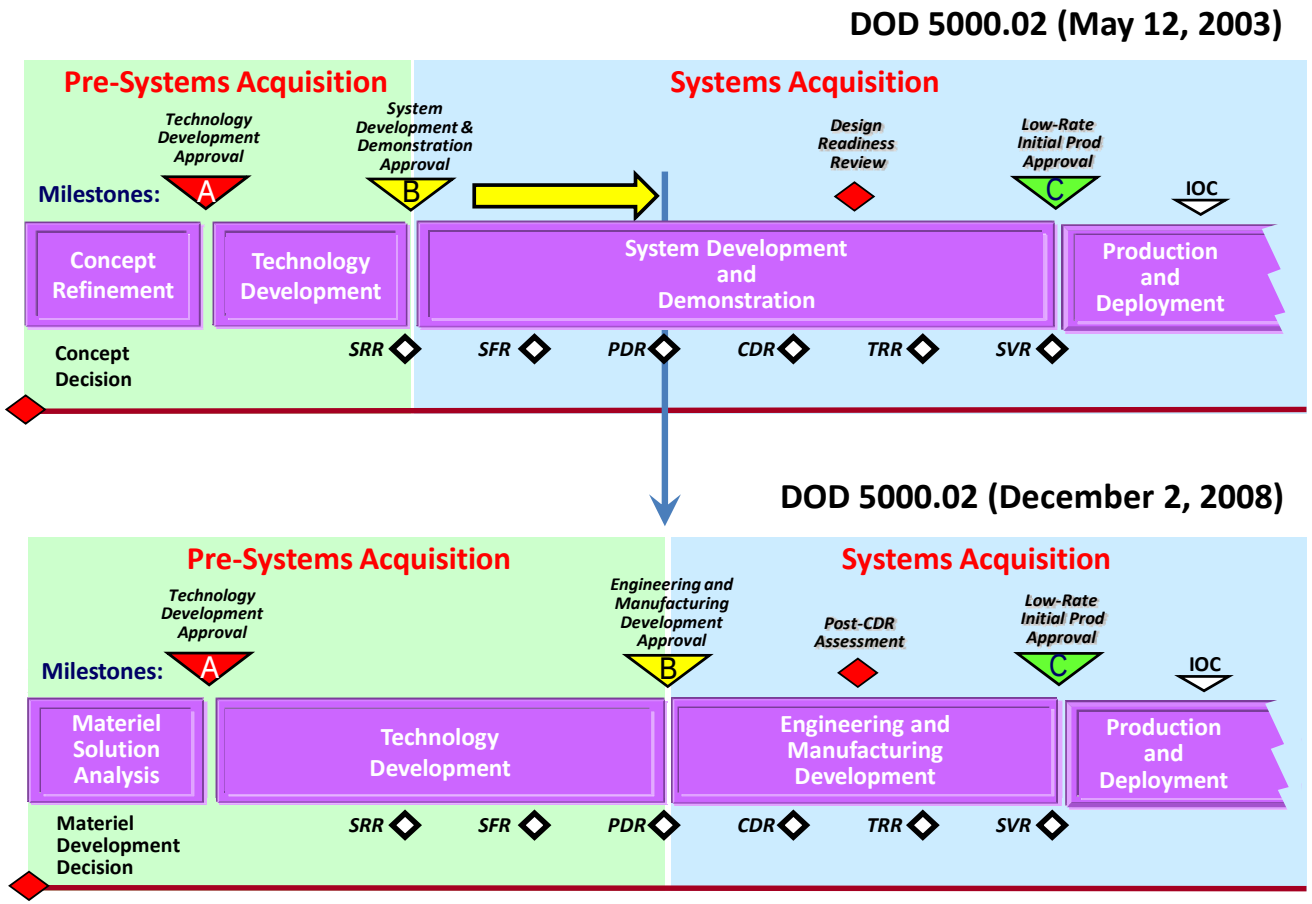
** Source: [DAPA 2006]*

Analysis: DAPA and Agility

- Do DAPA recommendations call for agility?
  - *The **stabilization** of the PPBE process is recommended*
  - *The proposed, new requirements process would have a **2-year duration***
  - *The creation of a **stable** Program Funding Account is recommended*
  - ***Predictability** is emphasized, time would become a KPP*
  - *All accounts to be programmed to a **high, 80/20 confidence** level*
  - *Realistic capability delivery rate to be **established very early***
  - *Test plans to be **established very early***

Most DAPA recommendations do not need agility, in fact they emphasize the opposite, i.e., stability and predictability

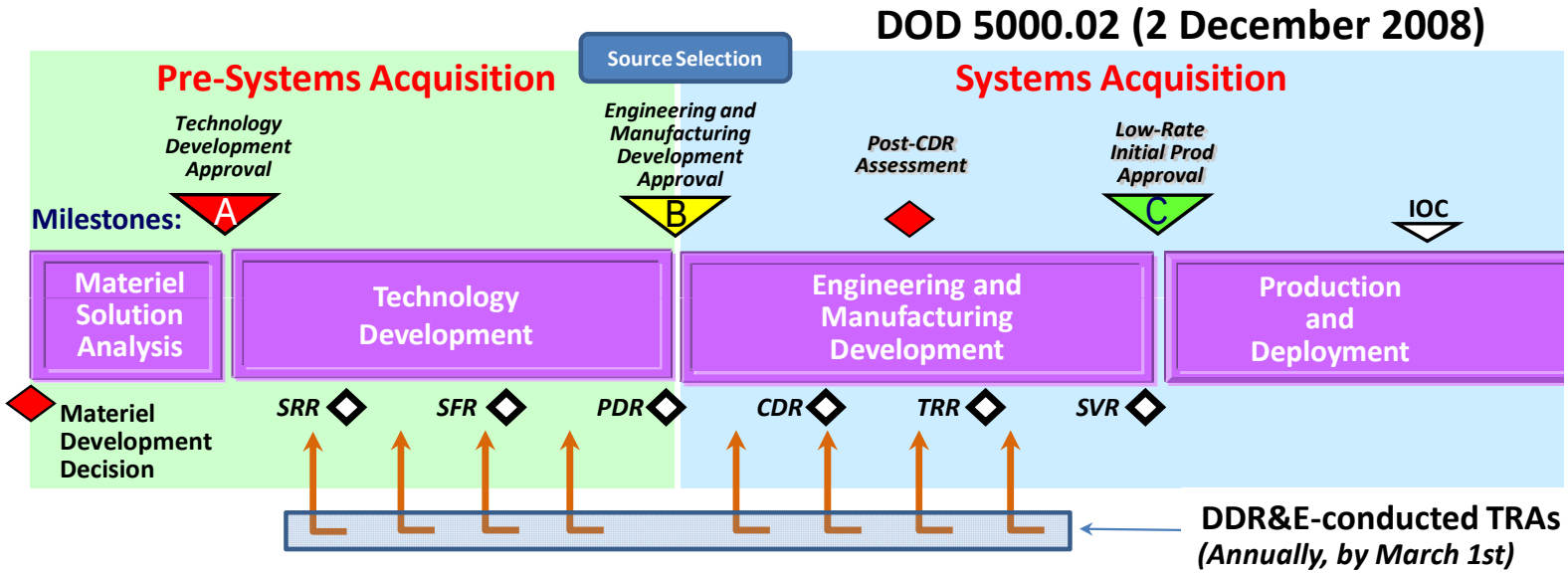
New DOD 5000.02 (December 2, 2008)



- Milestone B decision is realigned to occur at the Preliminary Design Review (PDR)

This alignment makes the front-end of the acquisition life cycle more loaded, indicating a waterfall, rather than agile process

Weapon Systems Acquisition Reform Act (WSARA) of 2009



- The Director of Defense Research and Engineering (DDR&E) shall annually conduct Technology Readiness Assessments (TRAs) and report results to the DOD and Congress
  - *This is a new requirement, in addition to the already established, formal TRAs at the Milestone Reviews*

Both the visibility and frequency of these new reviews guarantee the slow-down rather than the speed-up of the process

National Research Council /Air Force Studies 2009

- The National Research Council (NRC) was chartered to make recommendations to streamline Air Force and DOD Reviews*
  - *The committee identified 31 formal reviews of four types that take a substantial toll on the Program Manager and the Program Leadership Team, due to*
    - Excessive preparation and participation time
    - Diversion of attention from the execution of the program
    - Significant cost imposed
  - *The recommendations could only suggest the elimination or consolidation of six reviews*
    - However, the list did not show every possible ad-hoc review and did not indicate the pre-reviews and pre-briefs generated by these formal reviews either

This elaborate review structure and the underlying, fundamentally phase-gated process inherently prevents agility

** Source: [NRC 2009]*

The State-of-the-Affairs

- Agile Software Development experimentation is happening but due to numerous concerns the approach seems to be inadequate and undesirable in defense acquisition
- The Air Force Agile Acquisition Initiative did not gain any traction but was not comprehensive enough anyway
- The DAPA report emphasized predictability and stability; neither of them is an agile value
- The current, big "A" acquisition system has serious counter-lean tendencies
  - *Every new problem or failed project triggers a proliferation of new committees, oversight boards, policies, extensive documentation requirements, and processes*
  - *This is a systemic issue that needs to be addressed first*
    - The NRC experience shows that streamlining processes is extremely difficult in the current environment

The Way Forward

- Declaration of a proper set of agile values is needed for defense acquisition
  - *Agility is a business strategy, a value proposition based on a value system. It is essential to have a declared set of values that is*
    - Widely accepted by all stakeholders
    - Clear and unambiguous
      - *However, it was shown that different stakeholders have drastically different value systems which need to be reconciled*
        - Agile Software Development only uses one set of "politically correct" values and assumes unconditional buy-in from all stakeholders. Unfortunately, this assumption is not realistic, even in development
  - *While the actual Agile Software Development value statements might be inadequate, the path the authors of the Agile Manifesto devised to convey their ideas could be proven useful:*
    - Agile Values → Agile Principles → Agile Practices

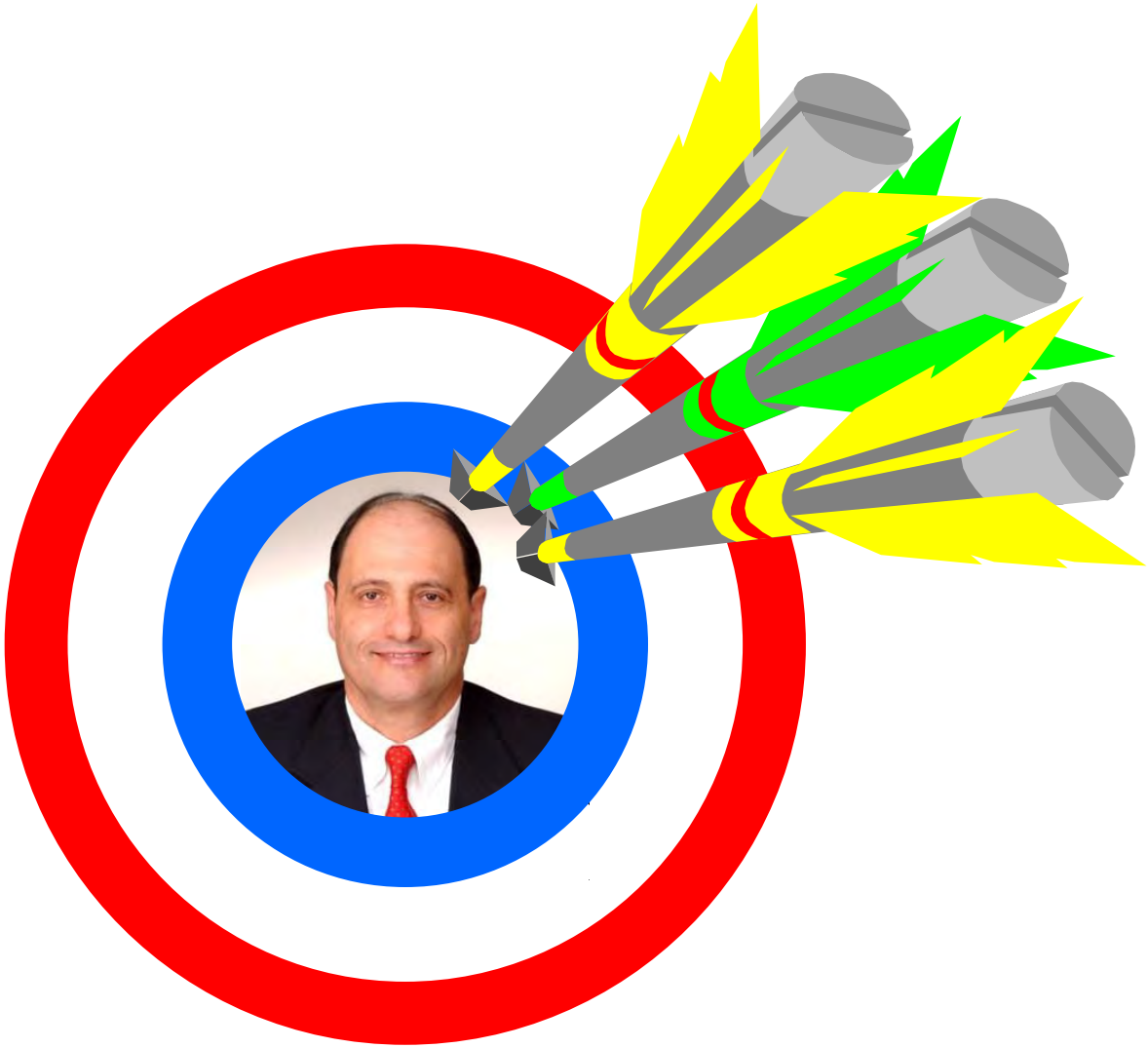
The Way Forward (cont.)

- It is possible that even if a shared set of values and principles are defined – depending on the scope – multiple practice mappings are needed
  - *Despite what some of the Agile Software Development proponents claim, agile software methods do not scale well*
  - *It can be safely assumed that in the localized contexts of JROC, PPBE, or the little "a" acquisition process, different agile practices need to be defined*
- Should we emulate the business approach of IT agility proposed by Drs. Masini and Sengupta [Masini 2005]?
  - *Their choice of terminology, i.e., **time-agility** and **range-agility** is not beneficial because it conflates the issues; Separate terms and basic definitions should be established for true agile values and rapid execution values*
    - Of course researching their relationship is still desirable
  - *Another caveat when using commercial models and metrics for defense acquisition is that the definition and role of Return on Investment (ROI) is drastically different in the two domains*

The Way Forward (cont.)

- The DAPA recommendation for using Systems Dynamics analysis ([DAPA 2006], Appendix D, pp 69-89) should be rigorously implemented
  - *The **impact** and **unintended consequences** of proposed new practices should be always evaluated via modeling and simulation before policy statements or other guidance is drafted*
- Current, relevant research efforts at The Aerospace Corporation
  - *Continuous monitoring of acquisition policy changes and evaluation of cost and risk implications [Hantos-Kern 2009]*
  - *Application of Systems Dynamics simulation to acquisition and development [Houston-Hantos 2010]*
  - *Application of Unified Life Cycle Modeling (ULCM ®,) a modern life cycle modeling approach developed at The Aerospace Corporation, to explore concurrent engineering risks in software-intensive systems development [Hantos 2008]*

Questions, Comments?



Acronyms

AFRL	Air Force Research Laboratory
CDR	Critical Design Review
CMMI	Capability Maturity Model Integration
DAPA	Defense Acquisition Performance Assessment
DDR&E	Director, Defense Research & Engineering
IOC	Initial Operational Capability
IOT&EP	Initial Operational Testing & Evaluation Plan
IR&D	Independent Research & Development
IV&V	Independent Verification & Validation
JCIDS	Joint Capability Integration Development System
JROC	Joint Requirements Oversight Council
KDSI	Thousand Delivered Source Instructions
KPP	Key Performance Parameter
MS	Milestone
NRC	National Research Council
OT&E	Operational Test & Evaluation
PDR	Preliminary Design Review
PPBE	Planning, Programming, Budgeting, and Execution
ROI	Return on Investment
SFR	System Functional Review
SRR	System Requirements Review
SVR	System Verification Review
SW	Software
TC	Transformational Communications
TEMP	Test & Evaluation Management Plan
TRA	Technology Readiness Assessment
TRR	Test Readiness Review
ULCM	Unified Life Cycle Modeling
WSARA	Weapon Systems Acquisition Reform Act

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